

# iSnobal/AWSM modeling system improvements and plans for WY2019

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# AWSM update and ops



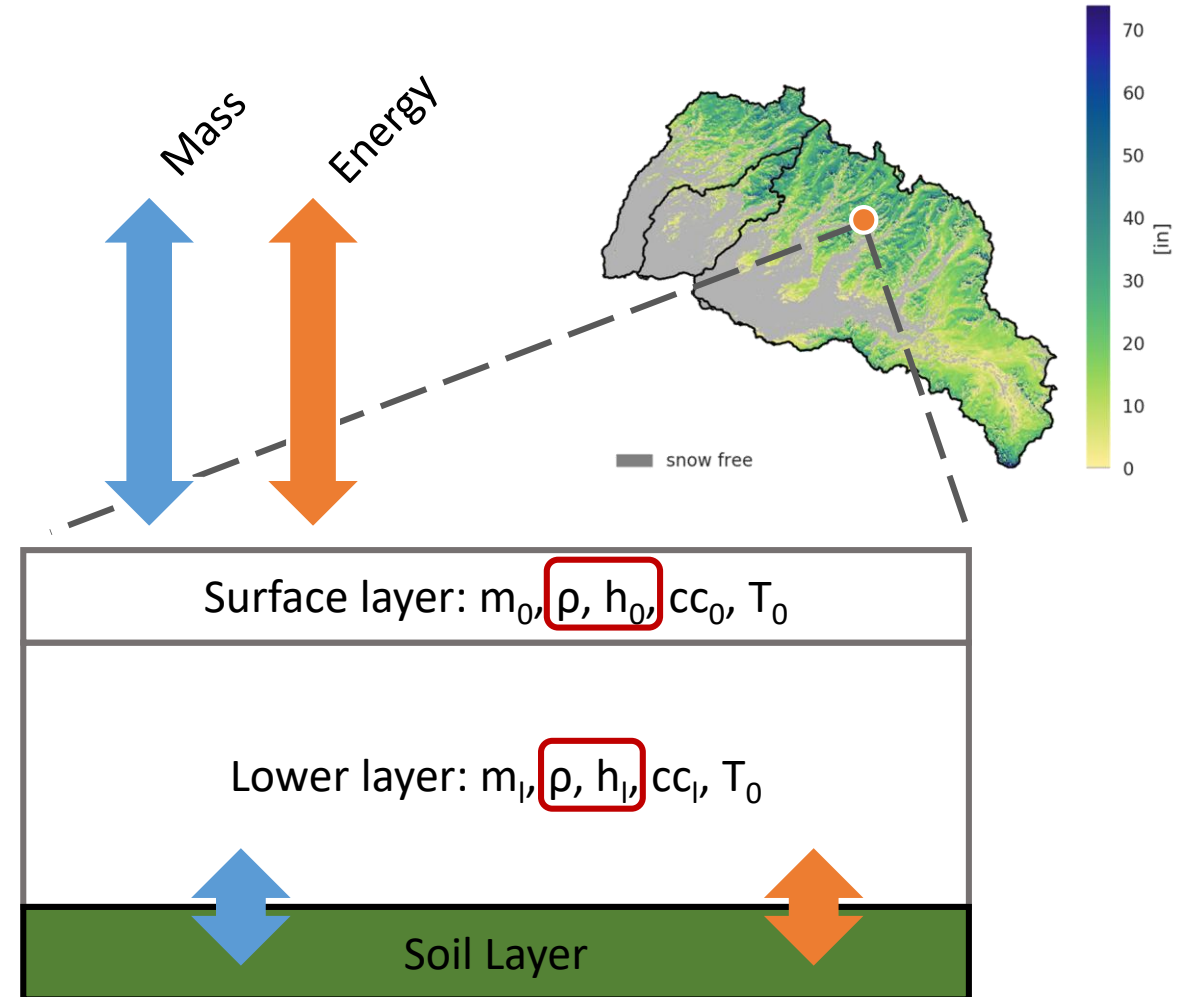
- Model backgrounds
- Motivation for improvements
- High Resolution Rapid Refresh (HRRR)
- WY2019 operational plans

# iSnobal Overview



SWE  
2018-4-30

- Physically based snow model (Marks et al., 1999)
  - Mass and energy balance of the snowpack
- Varying spatial and temporal resolution
- Input data
  - Cooperative measurement network
  - Using HRRR atmospheric model for WY2019



# Automated Water Supply Model

## AWSM



iSnobal

physically based  
model at the core of  
the modeling  
system

Everything else  
enables iSnobal  
simulations



### Automated Water Supply Model (AWSM)

- Streamline and standardize water supply forecasts
- Reproducible science

#### Core Components



#### Data

##### Station data

- CSV files
- MySQL database

##### Gridded

- Generic NetCDF
- WRF output
- HRRR output



#### SMRF

- Domain interpolation
- Point/gridded data to domain
- Flexible framework
- Reproducible



#### Models

##### IPW

- *iSnobal*
- Hydro-climate utilities

##### PySnobal

- Python wrapper



#### Data Analysis

##### SNOWAV

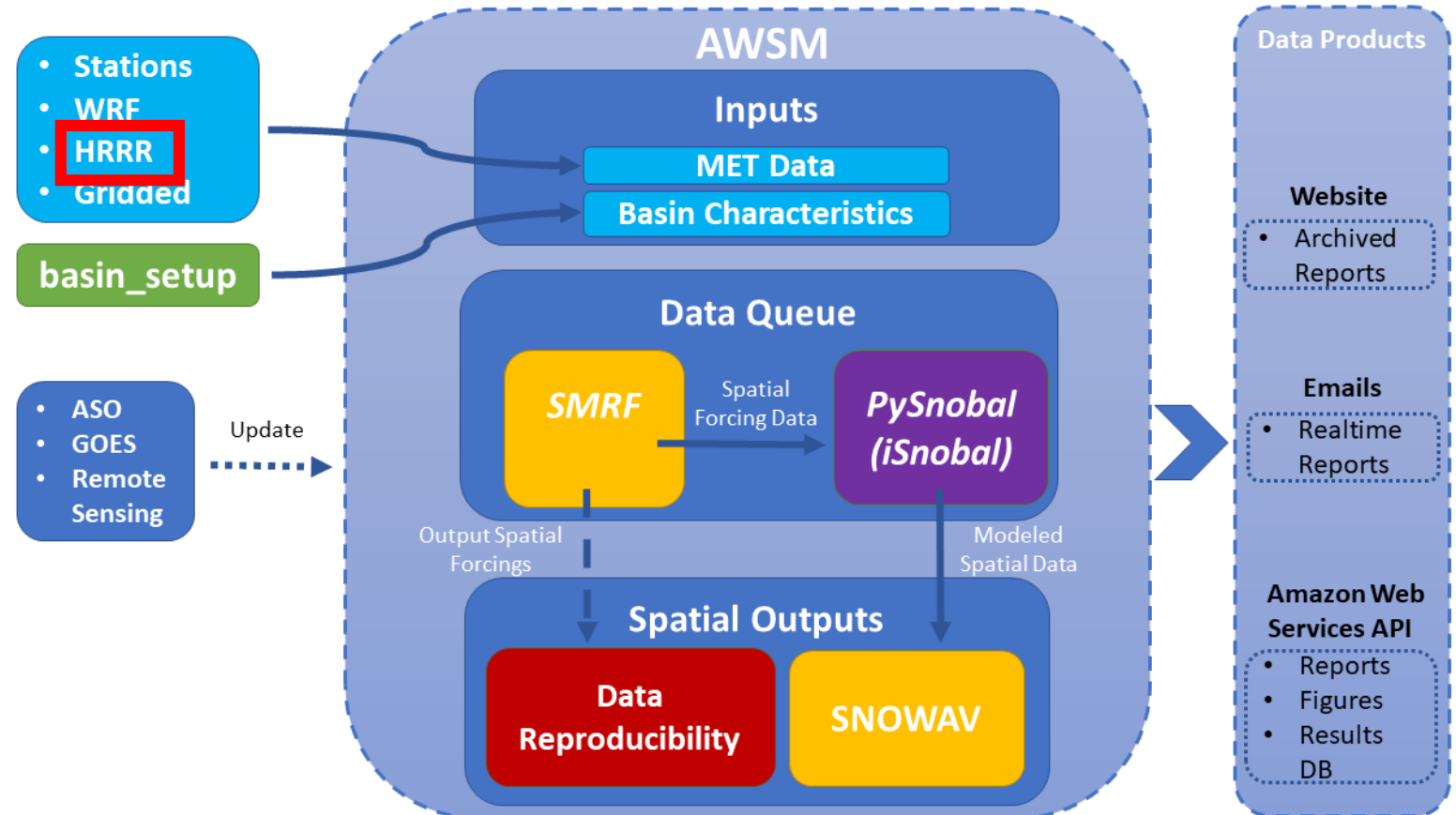
- Process outputs
- Analytics and insights
- Summary reports

# AWSM Modeling System

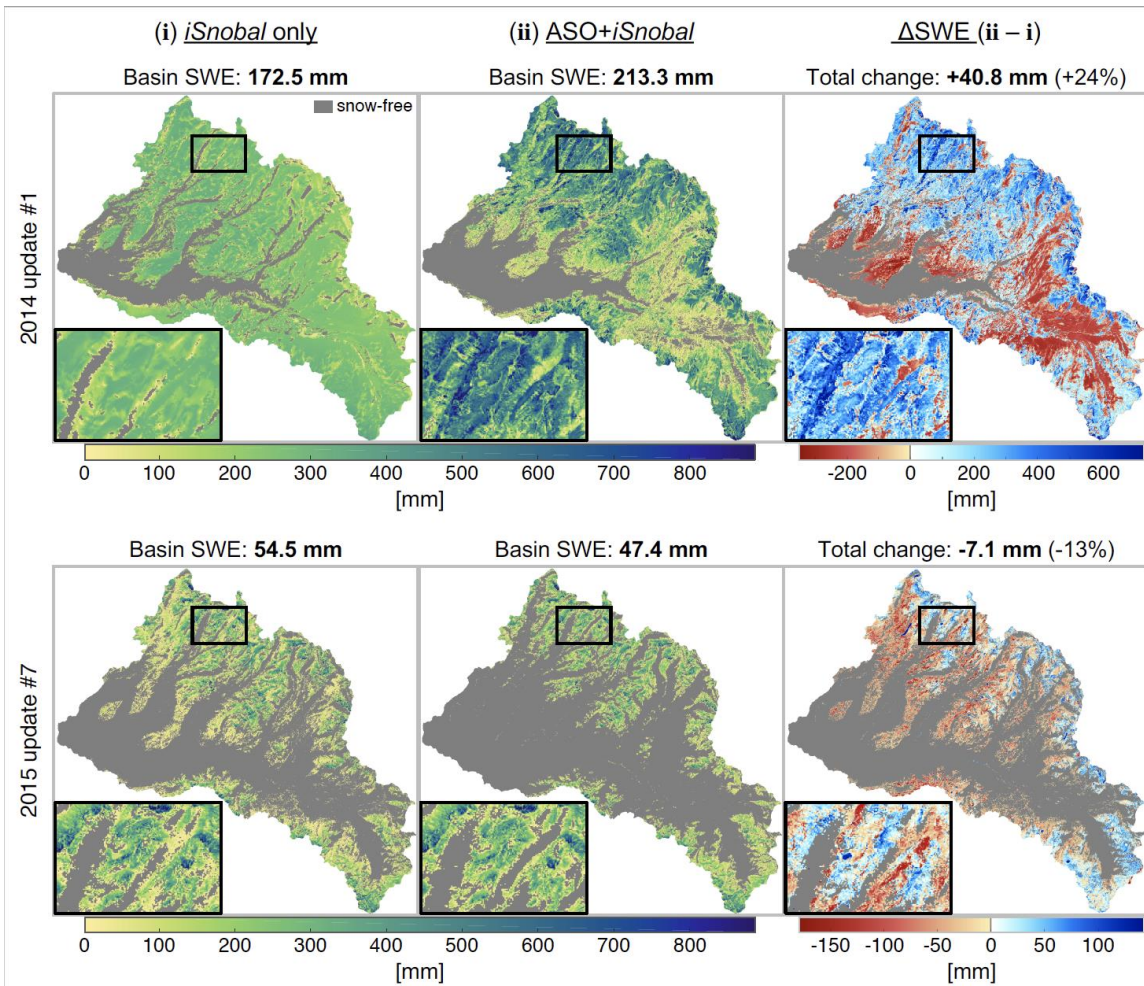


- Standardization of modeling workflow
- Built on core components
  - Each can be used individually
- AWSM replicates what ARS modelers do
  - Modeling automation

**Allows for real time modeling of multiple large watersheds**



# AWSM updating with ASO



## Examples of 2 updates

### 1. 3/23/2014

- First update of the year
- Large increase in SWE with ASO update

### 2. 5/1/2015

- eighth update of the year
- Small absolute change in SWE storage, but large relative decrease.

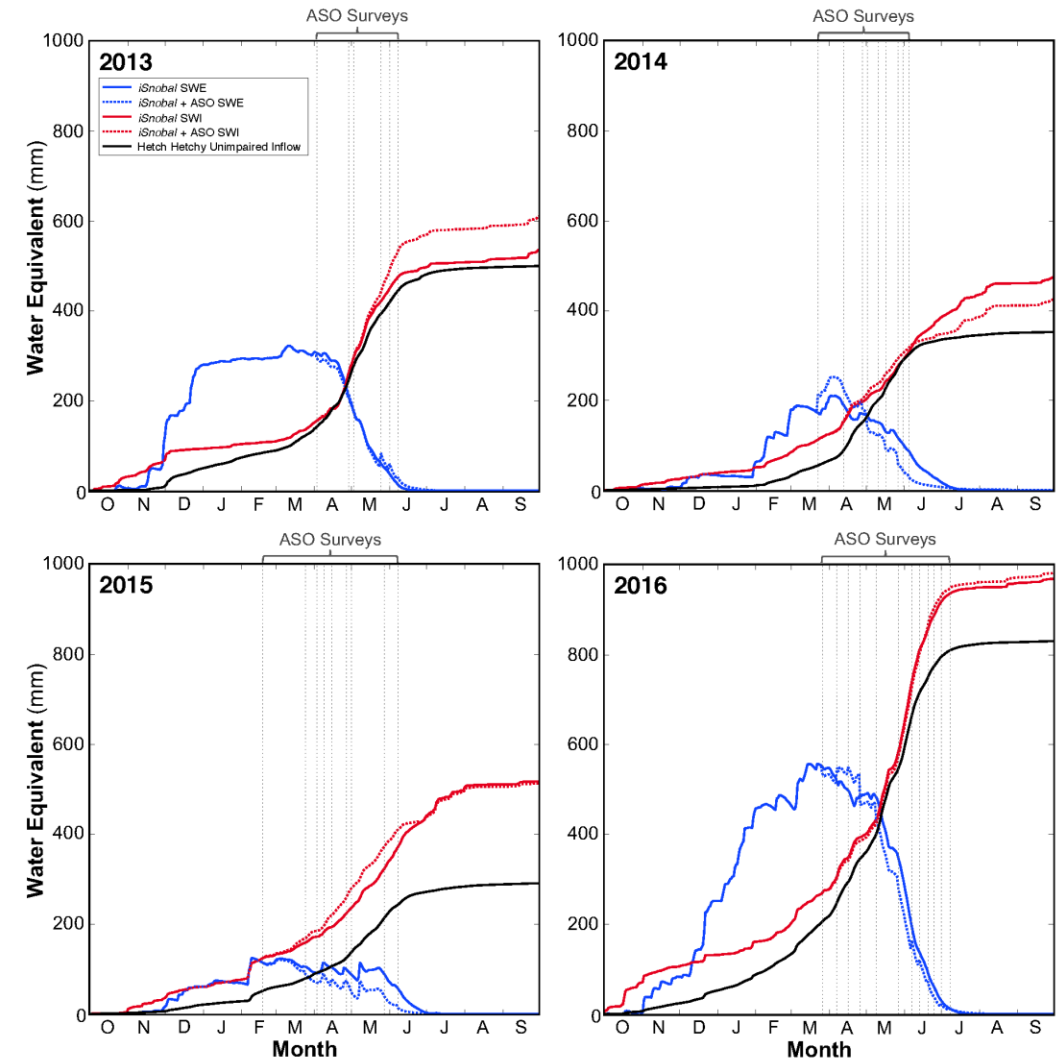
Insets show how ASO redefines the solid precip distribution.



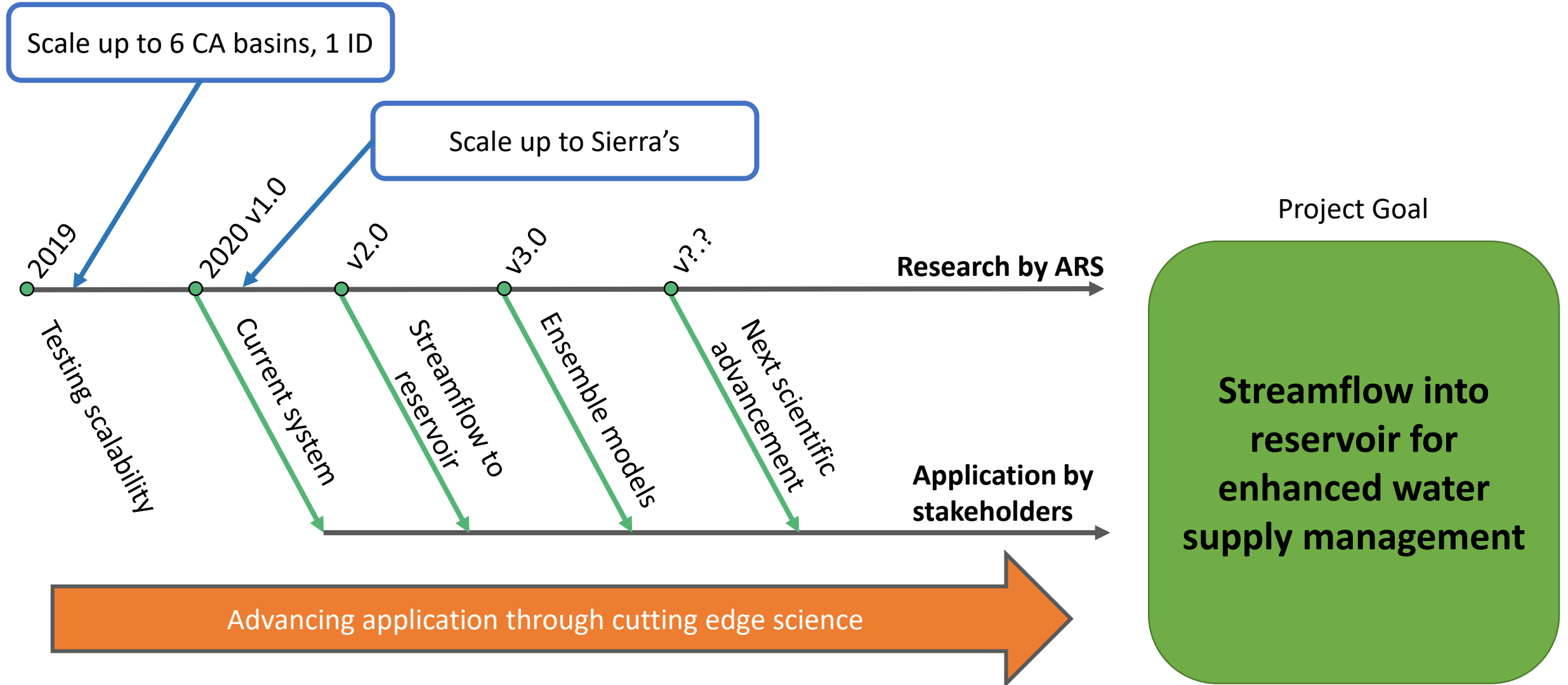
# Power of ASO + iSnobal



- ASO defines the snow distribution
  - Snapshot of what is on the ground
- iSnobal
  - Continuous results between flights
  - Short term forecasts, “History Repeats Itself”
  - How will the basin react
- When pillows say “0”, iSnobal + ASO will inform how much is left



# Modeling project timeline





# AWSM update and ops

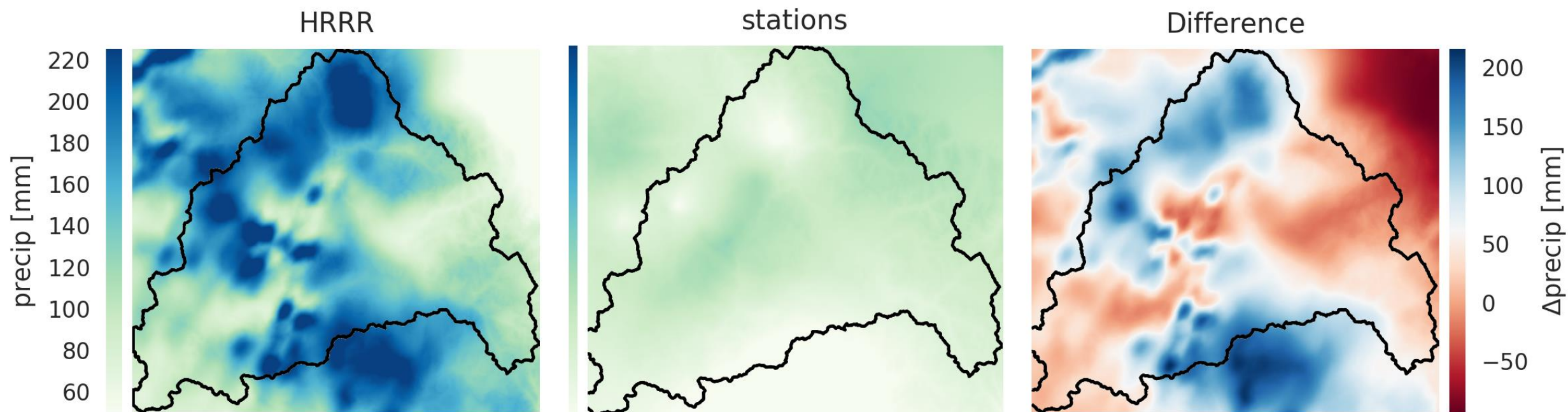


- Model backgrounds
- **Motivation for improvements**
- High Resolution Rapid Refresh (HRRR)
- WY2019 operational plans

# San Joaquin WY2018

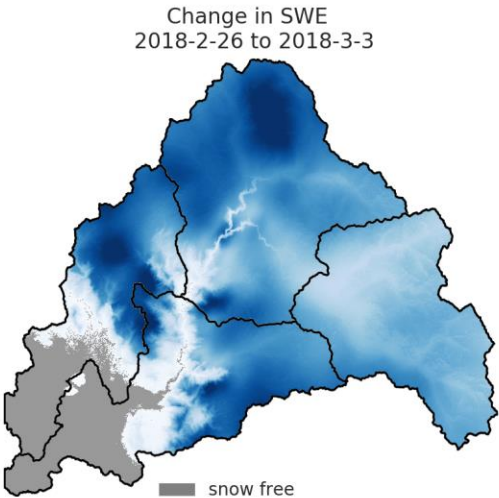


## Feb 26 storm event

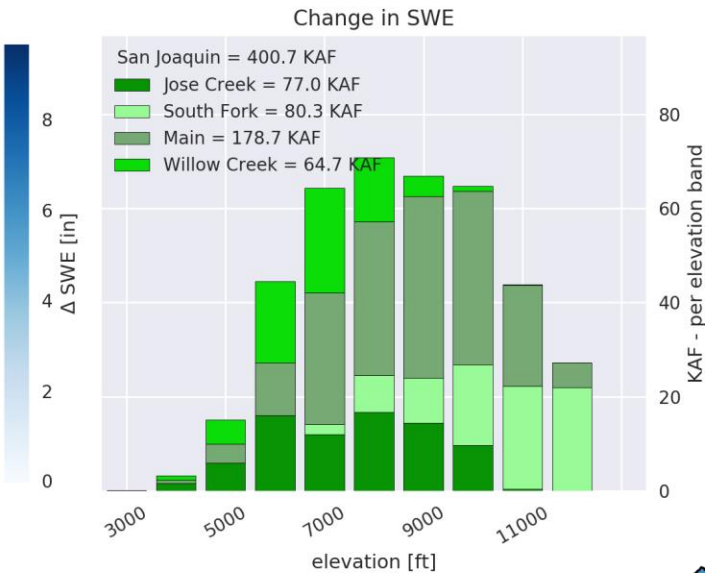


High Resolution Rapid Refresh (HRRR) from NWS

# San Joaquin WY2018



HRRR

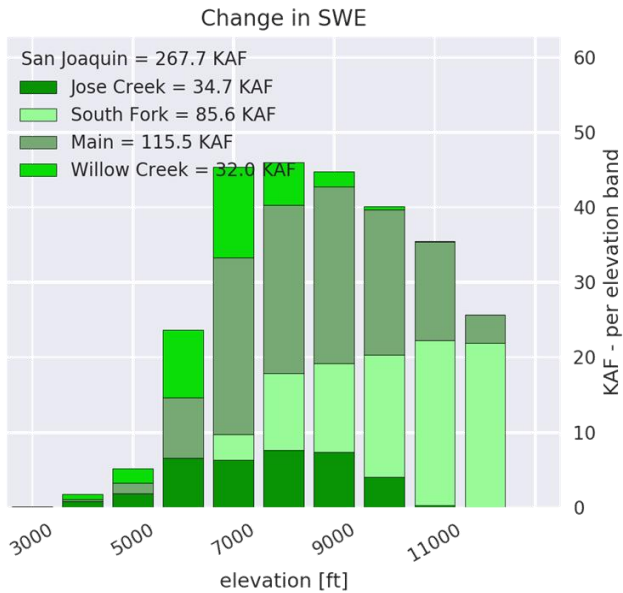
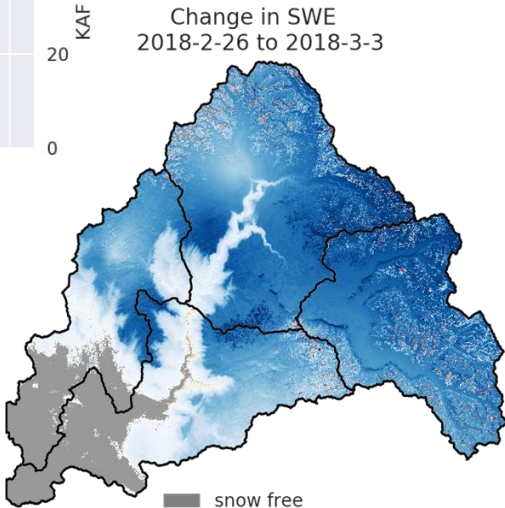


**Feb 26 storm**

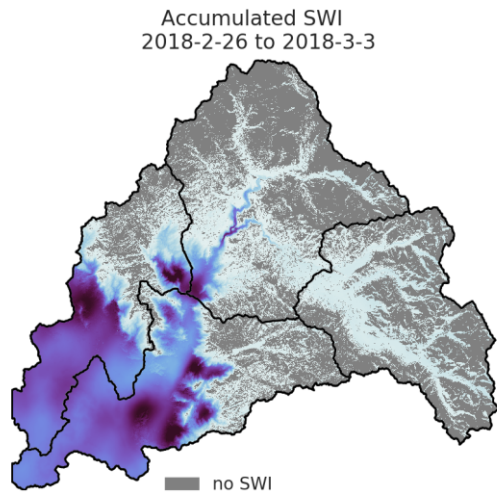
**Station: 268 KAF**

**HRRR: 400 KAF**

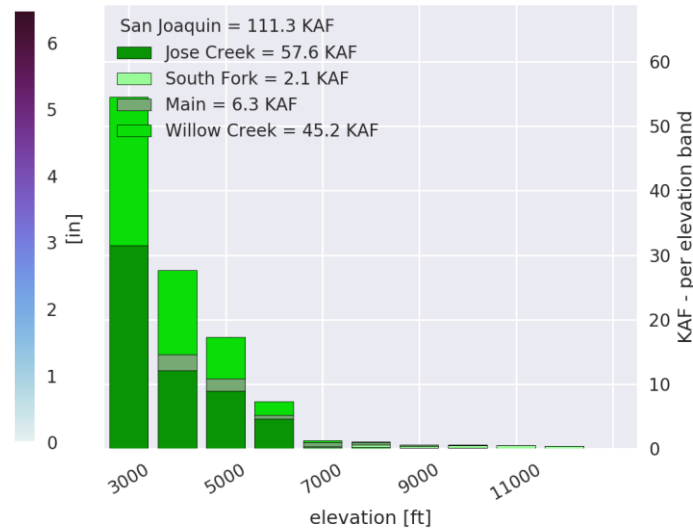
Station



# San Joaquin WY2018



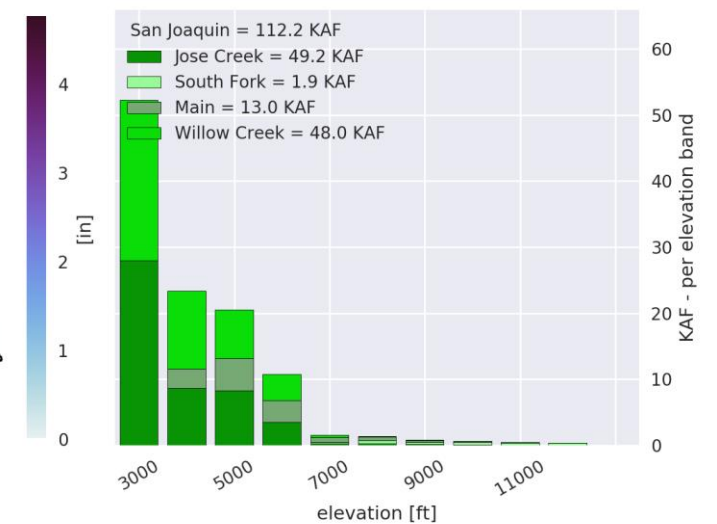
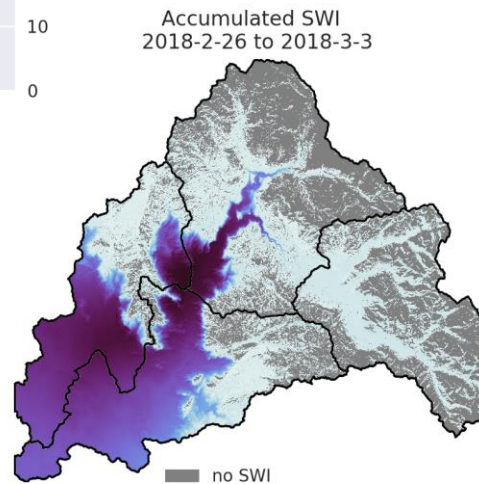
HRRR



## Feb 26 storm

- Surface water inputs similar
- Stations capture low elevation rain but not high elevation snow

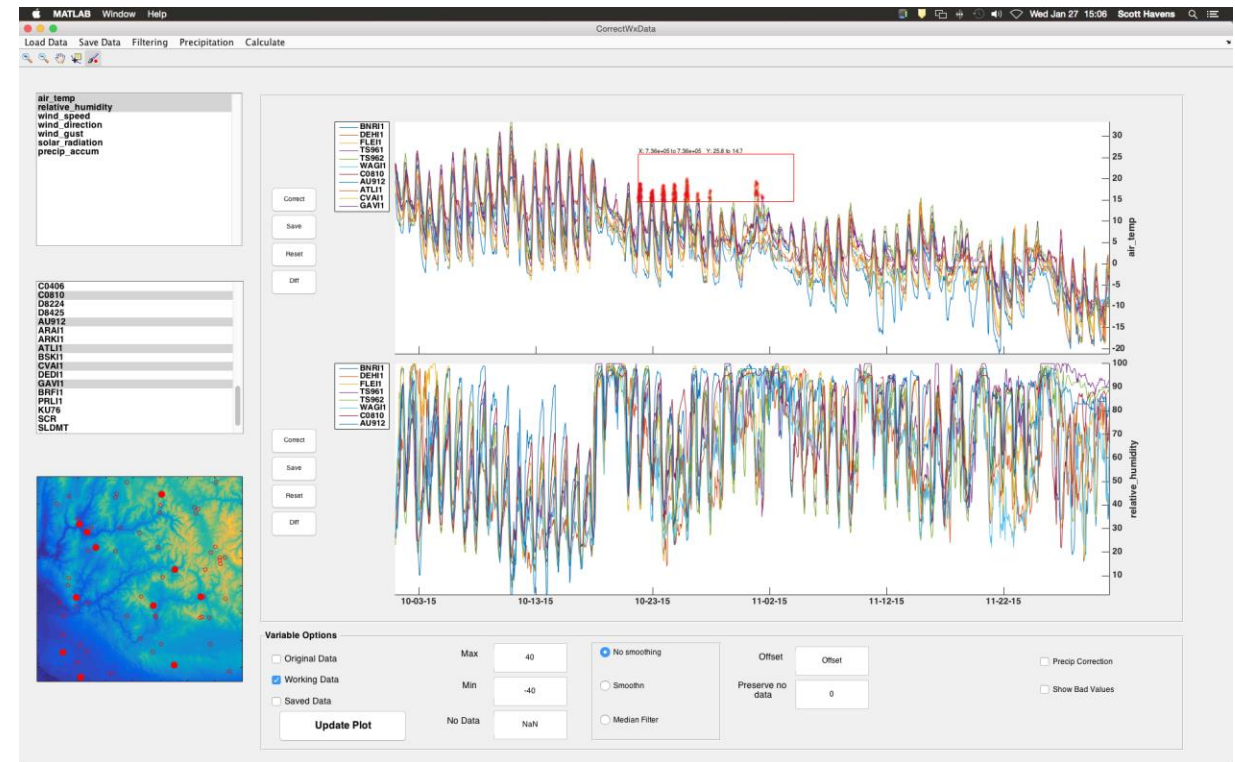
Station



# Scaling up operations



- 90% of the time is spent on QC of station data
  - Multiply by 6 and we have a QC nightmare
- Atmospheric models provide spatially and temporally complete inputs to iSnobal
  - Great for areas with sparse measurement networks
- Scalable to larger and larger regions



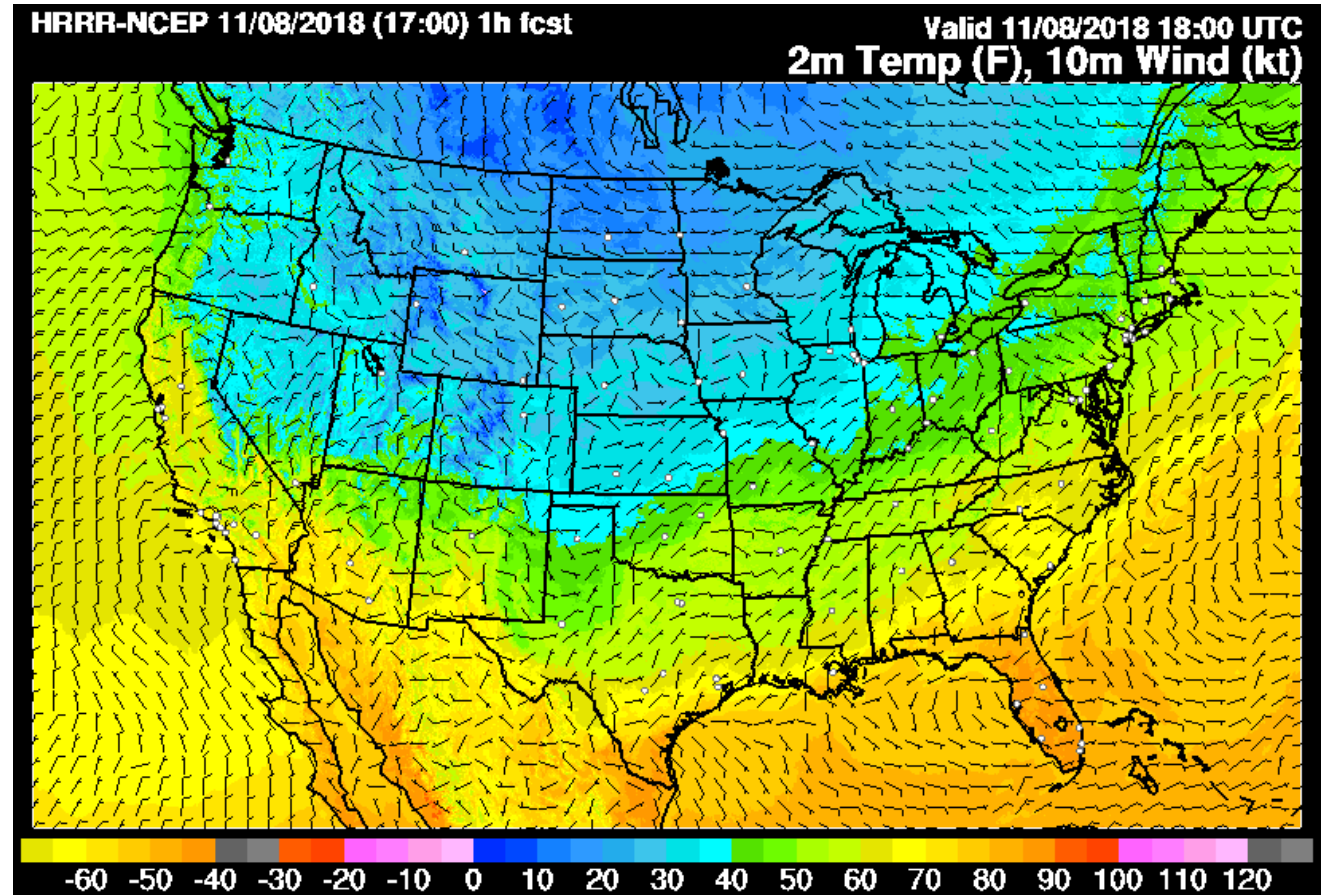


# AWSM update and ops



- Model backgrounds
- Motivation for improvements
- **High Resolution Rapid Refresh (HRRR)**
- WY2019 operational plans

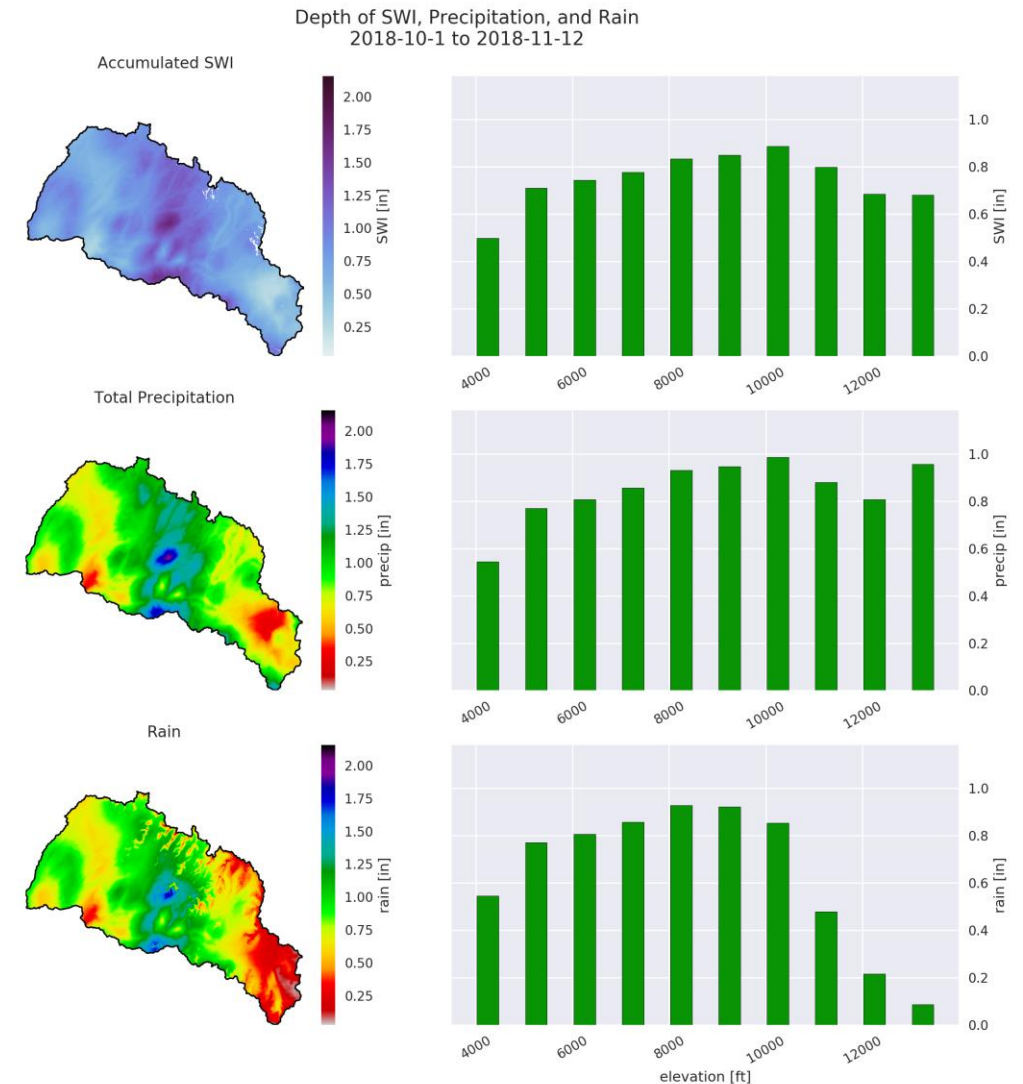
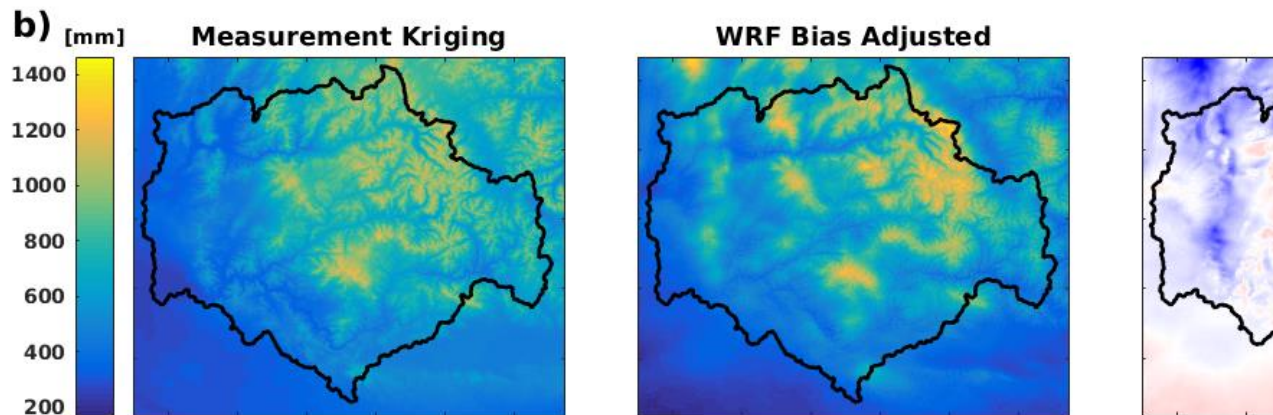
- Operation NOAA product
  - 3-km resolution
  - hourly updated
  - Data assimilation of satellite, radar and ground based obs
  - 18h forecast every hour, 36h every 6h
  - Started in 2015
- For real times run, we utilize the 01 forecast hour
  - Provides all variables needed for iSnobal





# HRRR precipitation

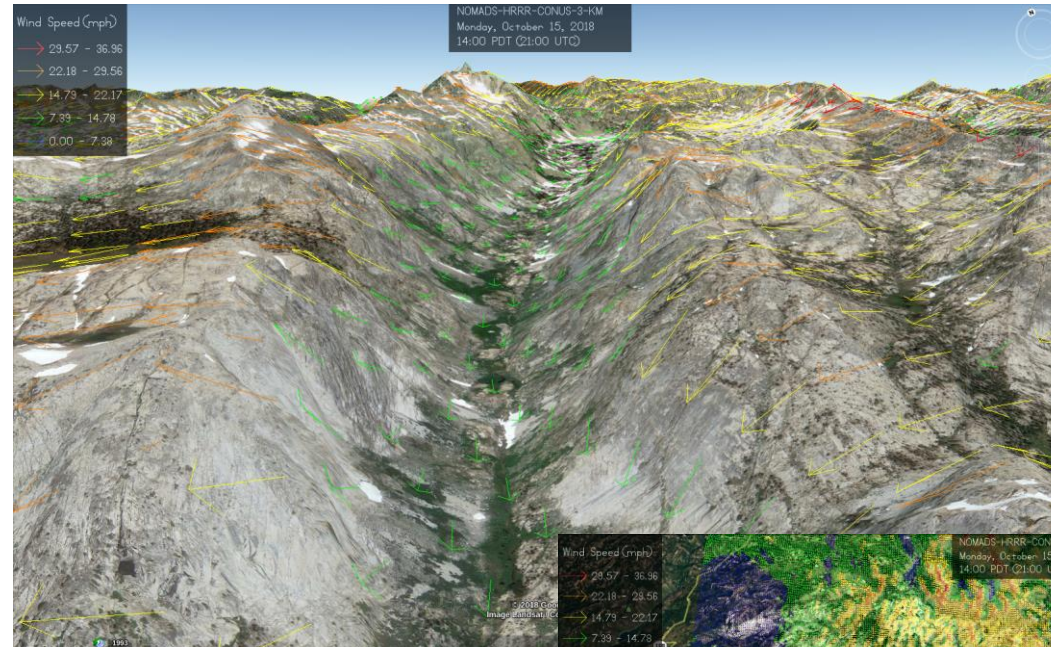
- The most important input to iSnobal
- Steeper elevation gradients than stations, typically



# HRRR wind

**Problem:** scaling from 3km to 50m

- Wind Ninja
  - USFS Rocky Mountain Research Station
  - Developed for wind forecasts in wildland fire applications
  - Mass and momentum solver
  - Built for operational use
- Accounting for fine scale topography on the wind field



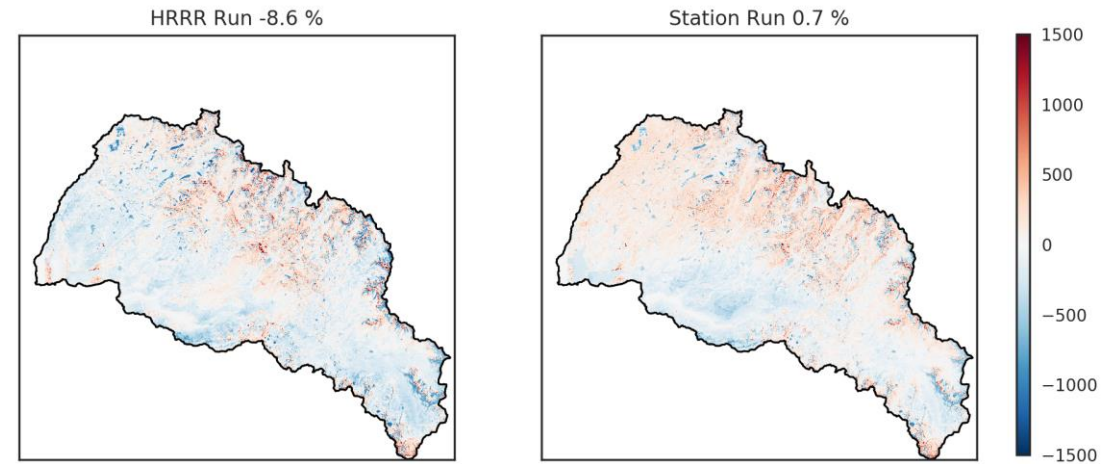


# HRRR ASO updates

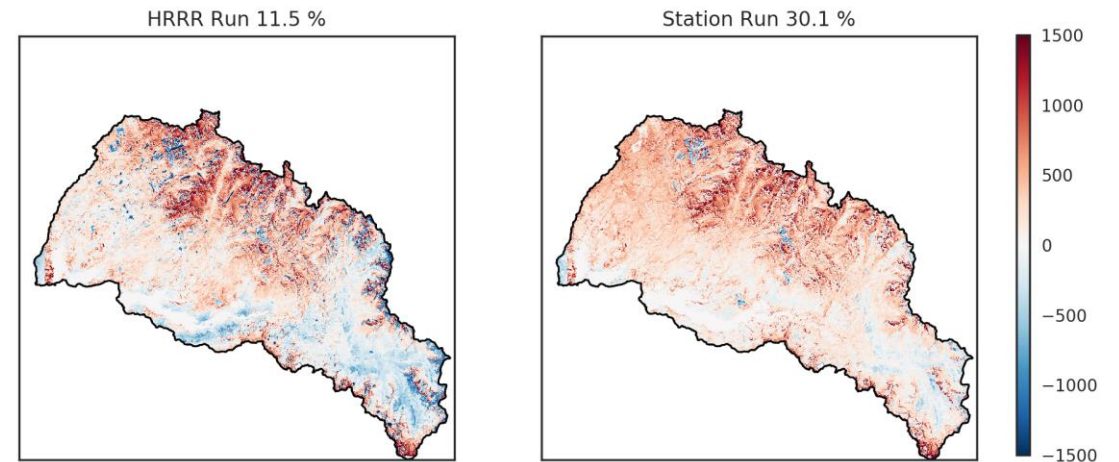


- Putting it all together for WY2017 in the Tuolumne
- 1<sup>st</sup> update Jan 28
  - -8.6% change
- 2<sup>nd</sup> update Mar 2
  - +11.5%
- Significantly less change in SWE with HRRR than with station data

Change in SWE [mm] from Update on 2017-01-28



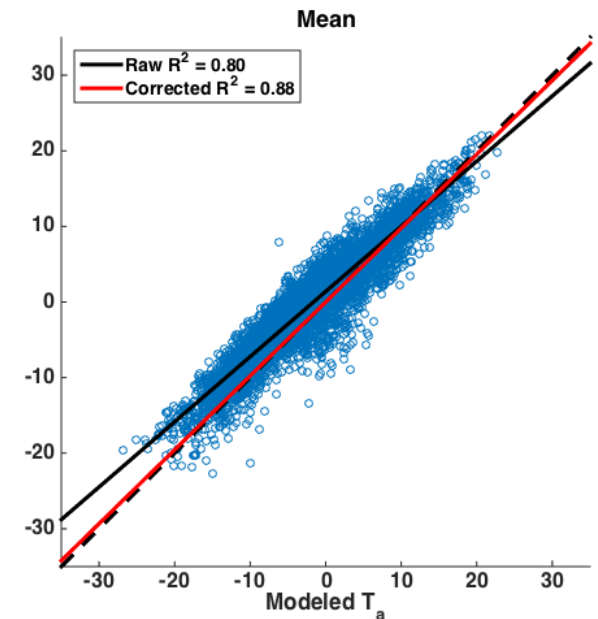
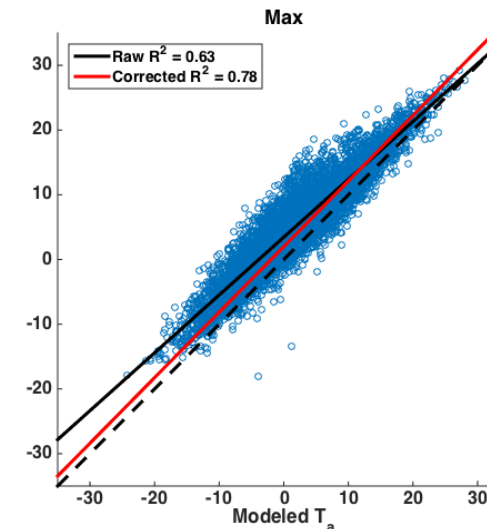
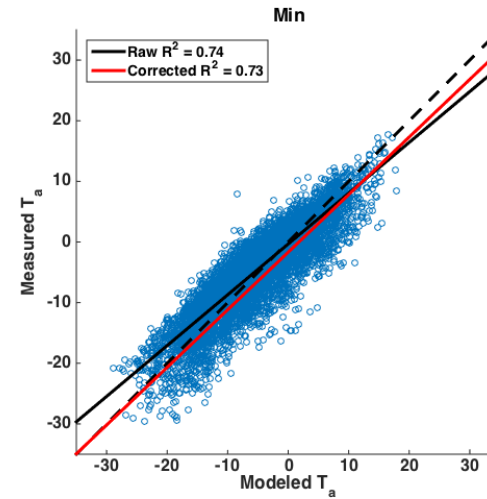
Change in SWE [mm] from Update on 2017-03-02



# HRRR deficiencies



- HRRR is a model used as input to another model
  - Compounding biases
- Diurnal temperature does not have the range as seen in measurements
- Higher precipitation biases existed in earlier versions and have been reduced
- Continually evaluating HRRR throughout the winter

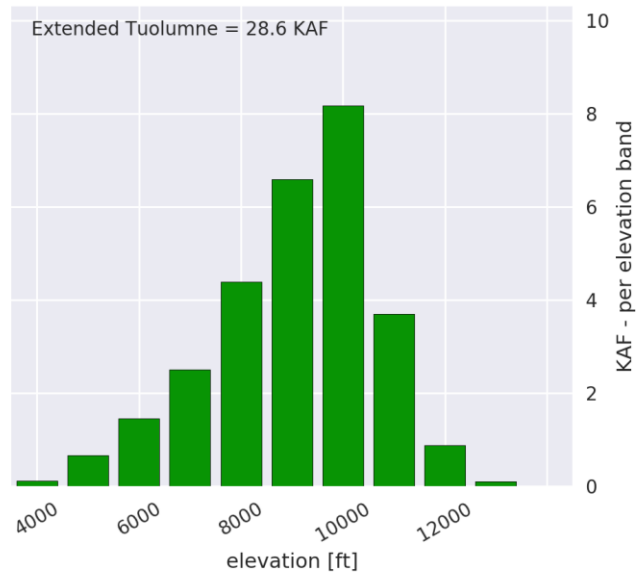
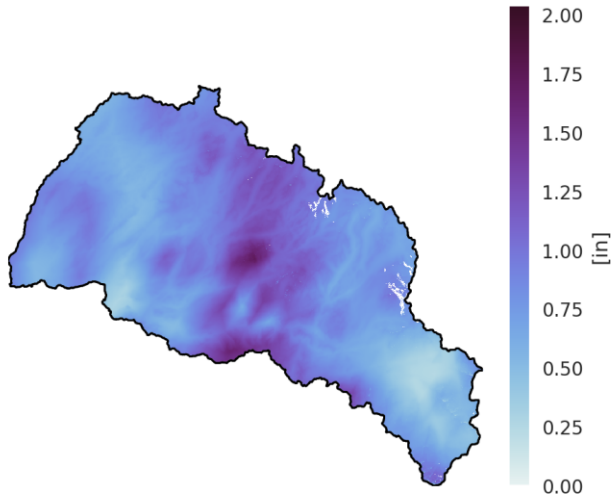


# Current Tuolumne results

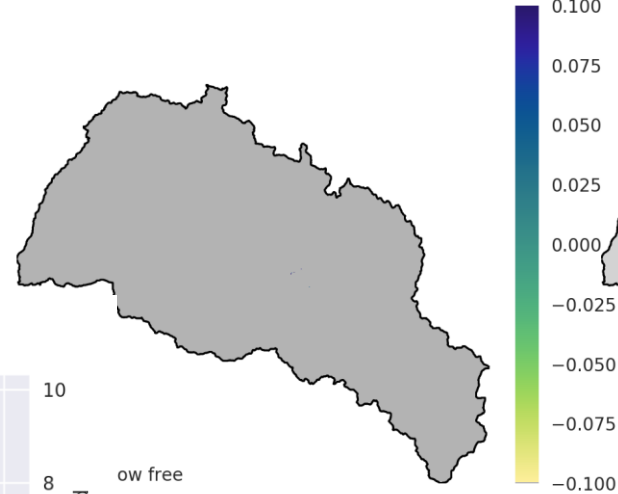


- Running daily, automatically
- 29 KAF SWI
- 0 KAF SWE

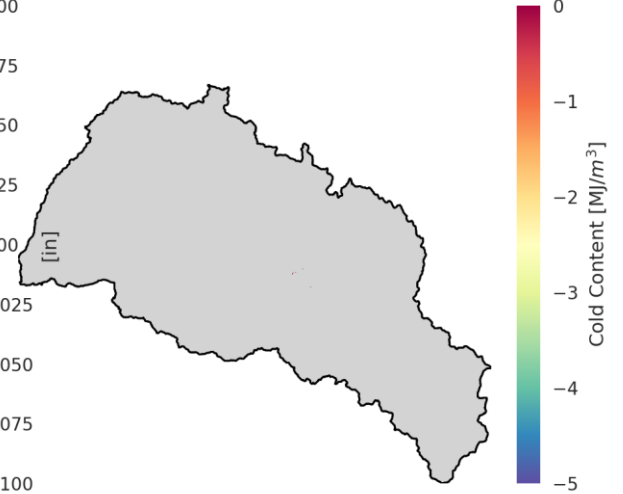
Accumulated SWI  
2018-10-1 to 2018-11-12



SWE  
2018-11-12



Cold Content  
2018-11-12



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- **WY2019 operational plans**

# WY2019 operational plans

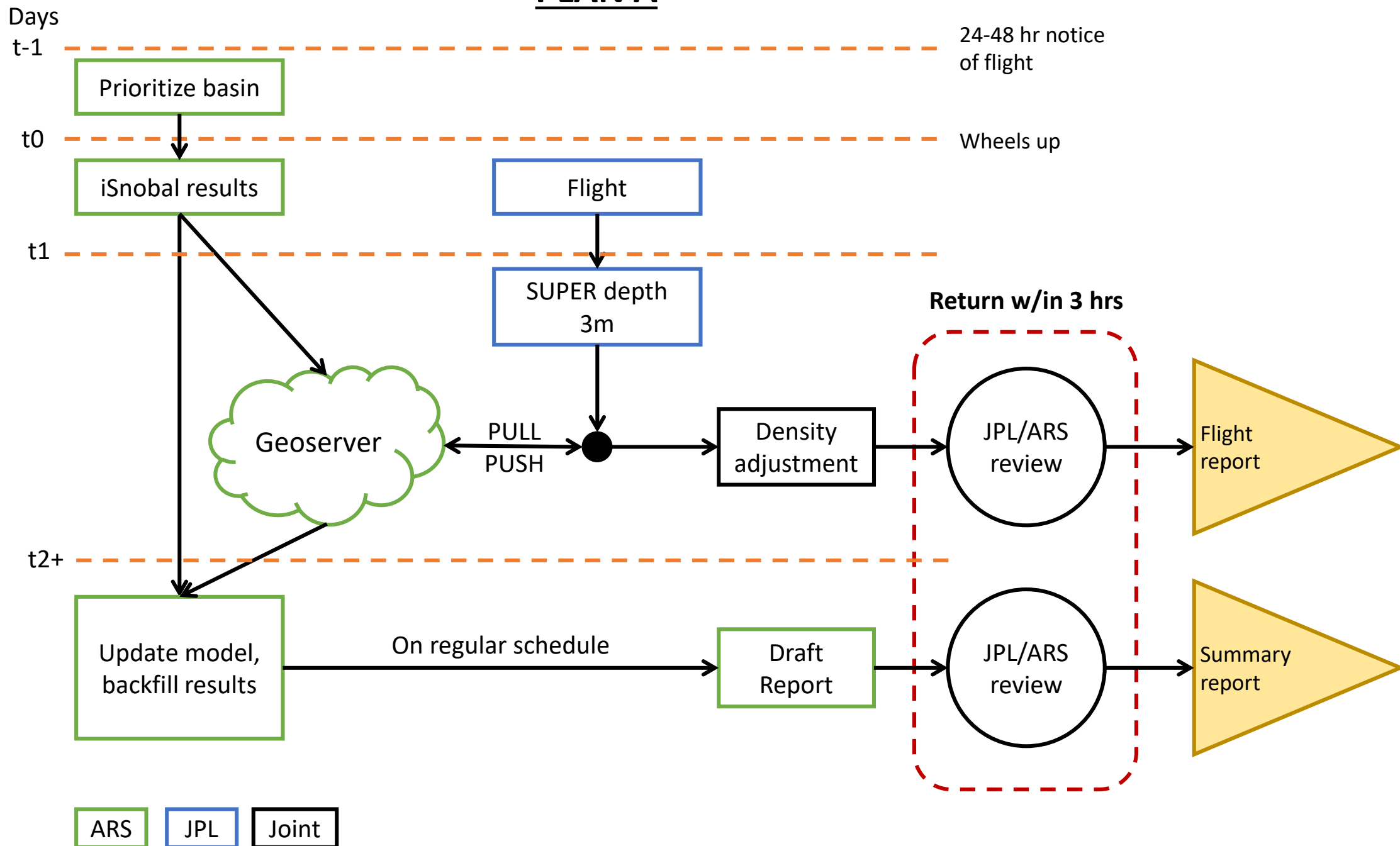


2019 Priorities	Basin	Report (PST)	Distribution schedule
	Tuolumne River	Monday 8a	2 weeks
	Merced River	TBD	2 weeks
	San Joaquin River	Wednesday 12:00pm	2 weeks
	Lakes Basin	Wednesday 12:00pm	2 weeks
	Kings River	Tuesday 12:00pm	2 weeks
	Kaweah	TBD	2 weeks
	Boise River Basin	Thursday	As needed
	East fork	Friday	As needed

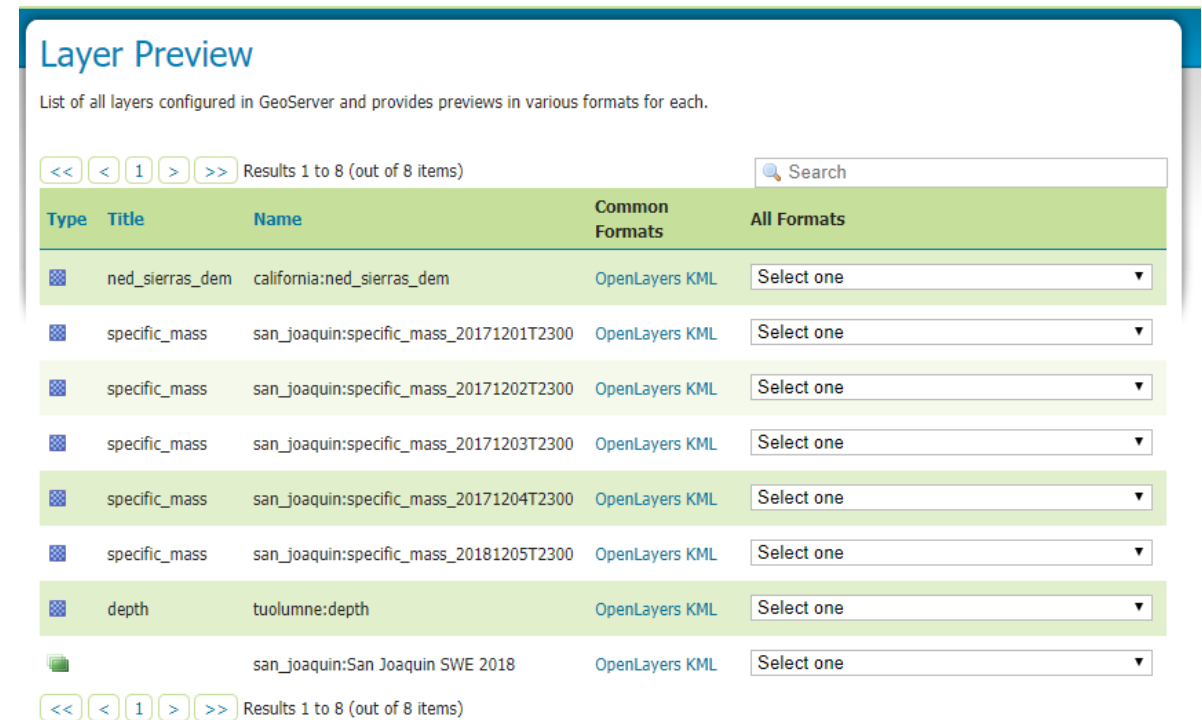
Month reports Jan 1 to Apr 1, bi-weekly after that











# PLAN A



- Sharing geospatial data
  - One stop shop
- Allows us to share all products in a standard way
  - Model: 50m daily SWE, SWI and density
  - Flight: 50m depth
- Expectation is that any user can access the model results at any time
  - Perform their own analysis (i.e. ArcGIS, PRMS)
  - Show a current map on webpage



The screenshot shows the 'Layer Preview' interface in GeoServer. It displays a list of 8 layers configured in the system. The interface includes a search bar, pagination controls (showing results 1 to 8 of 8 items), and a table with columns for Type, Title, Name, Common Formats, and All Formats. Each layer entry has a preview icon, a title, a name, a link to the OpenLayers KML, and a dropdown menu to select a format.

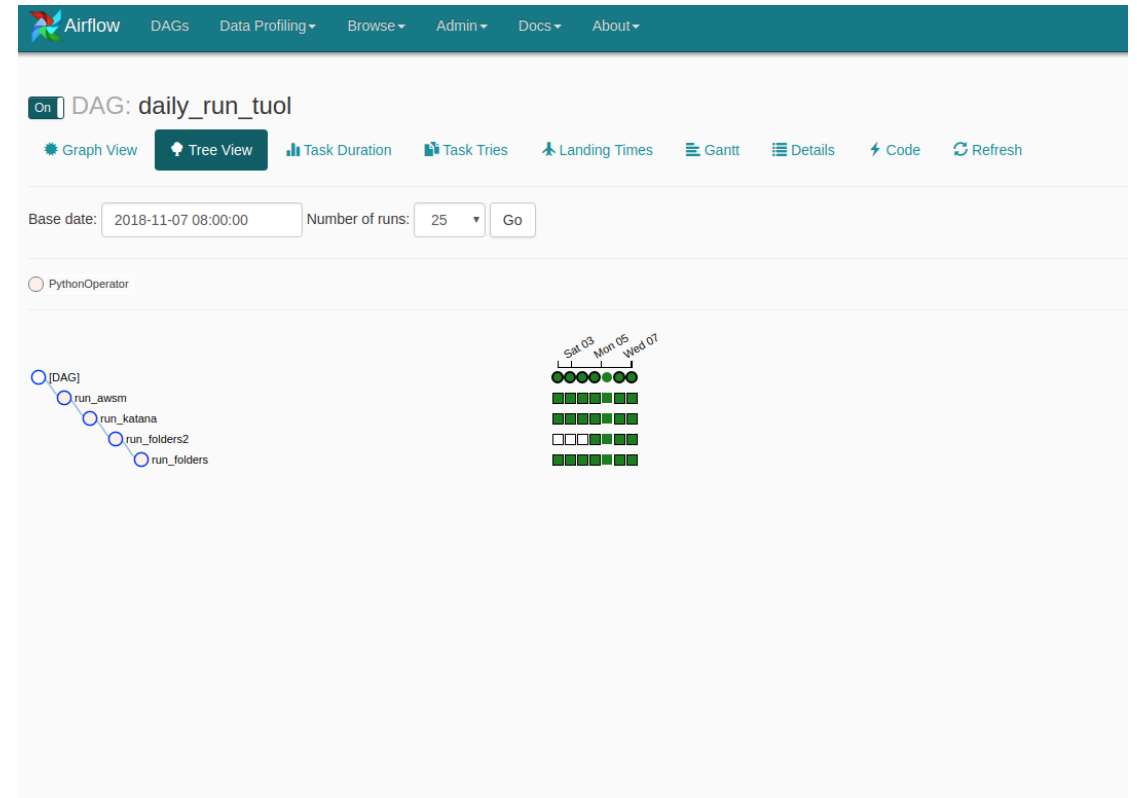
Type	Title	Name	Common Formats	All Formats
	ned_sierras_dem	california:ned_sierras_dem	<a href="#">OpenLayers KML</a>	Select one
	specific_mass	san_joaquin:specific_mass_20171201T2300	<a href="#">OpenLayers KML</a>	Select one
	specific_mass	san_joaquin:specific_mass_20171202T2300	<a href="#">OpenLayers KML</a>	Select one
	specific_mass	san_joaquin:specific_mass_20171203T2300	<a href="#">OpenLayers KML</a>	Select one
	specific_mass	san_joaquin:specific_mass_20171204T2300	<a href="#">OpenLayers KML</a>	Select one
	specific_mass	san_joaquin:specific_mass_20181205T2300	<a href="#">OpenLayers KML</a>	Select one
	depth	tuolumne:depth	<a href="#">OpenLayers KML</a>	Select one
		san_joaquin:San Joaquin SWE 2018	<a href="#">OpenLayers KML</a>	Select one

# Automation



## GOAL: Running daily, all basins

- Automate:
  - Push model results to Geoserver
  - Model updating after flight and re-pushing to Geoserver
  - Results should show up on Geoserver within a day
- Automation gives us more time to validate model results



# Keys to success in WY2019



1. Feedback on results, modeling new and unfamiliar basins.
2. Snow.

# Questions



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